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ART UNIT	**PAPER NUMBER**
2813	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/388,826	LI ET AL.	
	Examiner	Art Unit	
	Erik Kielin	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 October 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *102-124,126-131 and 133-140* is/are pending in the application.

4a) Of the above claim(s) *113,114 and 135-139* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *102-112,115-124,126-131,133,134 and 140* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *10/12/2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This action responds to the Amendment and IDS filed 12 October 2004.

Information Disclosure Statement

1. The IDS of 12 October has been considered to the extent that only US 6,638,875 qualifies as prior art under 35 USC 102. None of the other references listed in the PTO-form 1449 were filed prior to the filing date of the instant application and do not therefore qualify as prior art regardless of content.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims **102**-112, 115-124,126-128 and **129**-131, 133, 134, 140 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

The specification fails to enable one of ordinary skill how to "blanket expose the first layer to an oxygen comprising plasma… that allows the base chemistry of **the whole** deposited first layer to remain substantially without transformation to another base chemistry after the

blanket exposing converts the first layer to the insulative layer." See instant specification, which states,

> "It is a preferred intent of the exposing to further **not transform a whole of all of the dielectric layer** from one base chemistry to another base chemistry by the exposing. An **outermost portion of the exposed layer might experience a slight reduction in carbon content**, but otherwise that portion and the whole of the layer is not transformed from one fundamental material to another even in spite of the low k reducing or resulting property." (Emphasis added; page 12, lines 3-9.)

Additionally, the claims extend beyond the scope of the instant specification by failing to indicate which portion of the first layer remains unchanged by the exposure. It is not some unspecified portion, but is specifically that portion other than the surface region that remains unchanged according to the specification. This is the only untransformed portion of the insulative layer for which the specification provides support.

In addition to the admission in the instant specification that the base chemistry is transformed, the following additional independent evidence is provided, for example, for $(CH_3)_xSiO_y$ to fail to remain substantially as $(CH_3)_xSiO_y$. The prior art to be presented below clearly indicates that the oxygen plasma necessarily reacts with the methyl function, thereby breaking the bonds. See **Wang** et al. (US 6,028,015), **Morita** (JP 63-157443 A), or **Brinker** et al. (US 5,948,482) for verification; each, as indicated below, teaches that oxygen plasma necessarily removes a portion of the organic moiety from the dielectric layer.

Wang indicates that the oxygen plasma severs the Si-C bond of the $Si\text{-}CH_3$ moiety, stating

> AIn particular, for example, when the surface of such a low dielectric constant **methyl silicon oxide** insulation layer is exposed to **oxidizing or "ashing" systems, which are used to remove a photoresist mask from the low dielectric constant methyl silicon oxide** insulation layer, after formation of openings therein, it has been found that the **ashing** process results in damage to the bonds **(severance) between the methyl radicals**

> **and the silicon atoms** adjacent the surfaces of the low dielectric constant methyl silicon oxide insulation layer exposed to such an ashing treatment. The term "openings", as used herein, is intended to describe either vias between two layers of metal interconnects or contact openings between devices on the substrate and a metal interconnect layer. **This severance of the carbon-silicon bonds, in turn, results in removal of such organic materials formerly bonded to the silicon atoms** along with the organic photoresist materials being removed from the integrated circuit structure. The **silicon atoms from which the methyl radicals have been severed**, and which are left in the damaged surface of the low dielectric constant methyl silicon oxide insulation layer, have dangling bonds which are very reactive and become water absorption sites if and when the damaged surface is exposed to moisture.≅ (Emphasis added; column 1, line 52 to column 2, line 7.)

Wang indicates further in this regard,

> A...i.e., those silicon atoms **previously** bonded to organic radicals stripped from the silicon atoms by exposure to the **oxidizing/ashing treatment** used to remove resist mask 40. (Emphasis added; column 3, lines 50-52.)

Wang further indicates that the Aoxidizing/ashing≅ means of removing the photoresist is **O_2 (oxygen) plasma**, as below:

> AThe respective resist masks wo[u]ld then be removed from both wafers by a **standard ashing process** consisting of an **O_2 plasma**.≅ (Emphasis added; column 5, lines 3-5.)

Similarly, the translation of **Morita** states,

> AWhen this semiconductor substrate 1 is exposed to an **oxygen plasma** for ten minutes, the **organic functional groups** of **organic** silicon thin film 10 **are removed** to a desired depth, transforming into a silicon oxide film.≅ (Emphasis added; page 5 of translation, lines 5-9).

Similarly, Applicant admits that **Brinker** states,

> "Optionally, chemical treatment such as ozonolysis, oxygen plasma, photolysis and selective dissolution can be used to remove residual organic constituents in order to confer additional porosity on the film." (Emphasis added; column 5, lines 25-28.)

Because the only portions of the organosilicon compound are the non-oxygen and non-silicon portions, the only remaining function is that which is necessarily removed by the oxygen plasma, which **Brinker** indicates is the Aorganic constituents.≅ This specifically and necessarily means the R or R= ligands which **Brinker** indicates may be Aalkyl≅ of which Amethyl≅ or A-

$CH_3\cong$ is the simplest. (For verification, see Hackh=s Chemical Dictionary, page 27.) Ergo, the methyl groups are specifically and **necessarily** removed by the oxygen plasma.

Therefore, the express teaching of each of **Wang**, **Morita**, and **Brinker**, is that O_2 plasma **necessarily** removes at least some of the organic portion (i.e. methyl groups).

4. Claims **102**-112, 115-124, 126-128 and **129**-131, 133, 134, 140 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

The specification fails to provide support for the presently claimed combination of (1) using a dry oxygen plasma to deposit the first layer; (2) then converting the whole first layer to a the insulative layer using an oxygen plasma; and (3) without converting the base chemistry, reducing the dielectric constant of the insulative layer using an oxygen plasma. In short, the specification fails to provide support for this specific combination. While it is acknowledged that in **one group of embodiments** in the specification --presented at p. 6, line 21 to p. 8, line 24-- the first layer is deposited using an oxygen plasma, in these embodiments in which the oxygen plasma is used to deposit the first layer, there exists **no** step for converting the first layer into the insulative layer using an oxygen plasma because oxygen is already incorporated during the deposition of the first layer, as $(CH_3)_XSiO_Y$.

By contrast, in the presently claimed group of embodiments of independent claims 102 and 129, the specification --presented at p. 9, lines 1-24-- indicates that the first layer is

deposited by "plasma treatment" --**not** a "dry oxygen comprising gaseous material while generating a plasma in a chamber"-- and then converted to the insulative layer using an oxygen plasma specifically to incorporate oxygen. The specification states at p. 9, lines 1-24,

> "Such describes but **one example process** of forming an interlevel dielectric layer, here by chemical vapor deposition with or without plasma in a chemical vapor deposition chamber [referring to the previous embodiments]. In but **another** considered **example**, a gaseous precursor compound is introduced into a chemical vapor deposition reaction chamber and subjected to **a plasma treatment** [--**not** dry oxygen plasma--]. A semiconductor substrate is provided in the chamber, and **material comprising carbon and silicon** [--**not** carbon, silicon, and oxygen--] is deposited from the plasma-treated precursor compound to over the substrate. **After** the material is deposited, it is exposed to an **oxygen containing moiety** and **converted** to a second material comprising silicon, carbon and **oxygen**." (Emphasis added.)

> "In a more specific example, methylsilane is flowed into a reaction chamber at a pressure of from 300 mTorr to about 30 Torr (preferably from about 1 Torr to about 10 Torr) and subjected to a plasma formed at a power of from about 50 watts to about 500 watts (preferably from 100 watts to about 200 watts). A semiconductor substrate is provided in the reaction chamber and maintained at a temperature of about 0 °C to about 600 °C. The **plasma treated methylsilane** deposits a material comprising **methyl groups and silicon** over the substrate. The deposited material is **then** exposed to an oxygen-containing moiety to convert the material to $(CH_3)_XSiO_Y$. Accordingly in this example from the **oxygen exposure, a whole of the deposited dielectric layer is transformed** from one base chemistry (i.e., that comprising a nondescript **combination of methyl groups and silicon**) to another base chemistry (**i.e.**, $(CH_3)_XSiO_Y$) by the **oxygen exposure**." (Emphasis added.)

Importantly, the above excerpted embodiment group is contrasted with the embodiment group presented on p. 6, line 21 through p. 8, wherein $(CH_3)_XSiO_Y$ is **directly deposited using an oxygen plasma** and methyl silane, and therefore **not** converted from one base chemistry to another in a separate step because it is already $(CH_3)_XSiO_Y$.

In summary, there exists **no** support in the specification to use oxygen plasma to deposit the first layer and then to wholly convert the first layer --already having oxygen-- into the insulative layer containing oxygen because it would already have the oxygen present from the deposition step. Accordingly, the specification fails to provide support for the presently claimed **combination** of steps presented in the claims. This is new matter.

The remaining claims are rejected for depending from the above rejected claims. Separate but similar rejections exist for dependent claims 116 and 117 because they specifically require the first layer to be $(CH_3)_XSiO_Y$.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claims **102**-105, 107, 108, 110-112, 115-121, 124, 126-128 and **129**, 131, 133, 134, 140 are rejected under 35 U.S.C. 102(e) as being anticipated by US 5,593,741 (**Ikeda**).

Ikeda discloses a method of forming low dielectric constant, interlayer dielectric comprising,

loading a substrate **12** including at least partially formed integrated circuitry **110** thereon into a reaction chamber for a plasma enhanced chemical vapor deposition apparatus (Fig. 1; col. 4, line 46);

with the substrate **12** in the reaction chamber, chemically vapor depositing a first layer **122**, having a first dielectric constant and comprising silicon atoms bonded to carbon atoms (col. 4, lines 30-39), over the substrate and on the at least partially formed integrated circuitry by introducing into the reaction chamber a gaseous material precursor (col. 4, lines 30-39) and a dry oxygen-comprising gaseous material (col. 4, lines 40-42) while generating a plasma in the reaction chamber (Figs. 1, 3(A), 3(B); col. 6, lines 9-51); and

after depositing, blanket exposing the first layer **122** to an oxygen comprising plasma that forms the low dielectric constant insulative layer **120** from the first layer **122**, that inherently reduces the first dielectric constant to a second dielectric constant that is the relatively low dielectric constant for the insulative layer allow and that allows a base chemistry of the whole deposited first layer to remain substantially without transformation to another base chemistry **after** the blanket exposing converts the first layer to the insulative layer, and that is shown to not appreciably etch the first layer (Figs. 1, 3(A), 3(B); col. 6, lines 9-51).

(See also Figs. 4(A)-4(E) and the associated text at col. 6, line 52 to col. 7, line 25.) While **Ikeda** does not discuss the dielectric constant of the "film-forming precursor 122", it is held, absent evidence to the contrary that the dielectric constant is reduced upon exposure to the oxygen plasma, by admission of Applicant in the instant specification. (See instant specification, p. 11, line 12, to p. 12, line 14.) **Ikeda** uses the same plasma conditions and materials as presently claimed. (See Ikeda, col. 4, lines 30-42; col. 5, lines 15-46; and the Examples in cols. 8-14.)

See *In re Swinhart*, 169 USPQ 226,229 (CCPA 1971) (where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not

possess the characteristics relied on) and *In re Fitzgerald*, 205 USPQ 594 (CCPA 1980) (the burden of proof can be shifted to the applicant to show that subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 USC 102 or obviousness under 35 USC 103).

Note also that in the decision in *Toro Co. v. Deere & Co.*, 69 USPQ2d 1584 (CA FC 2004), at page 1590, last paragraph, it was held that if "one or more embodiments -- whatever the settings of their operational features -- [] necessarily include or result in the subject matter of [the] limitation," then inherent anticipation of the limitation exists.

Regarding claims 103-105, 107, 108, **Ikeda** discloses oxygen and ozone, which are dry, oxygen comprising gases and a methyl silane (col. 4, lines 30-42).

Regarding claim 110, the stability of the dielectric layer is inherently increased for the reasons indicated in by Applicant and **Ikeda** (Ikeda at col. 6, line 9 to col. 7, line 29).

Regarding claim 111, **Ikeda** disclose the blanket exposing occurs within the reaction chamber without removing the substrate from the reaction chamber between chemical vapor depositing and blanket exposing.

Regarding claim 112, **Ikeda** discloses the temperature during exposure must be less than 550 °°C, i.e. 200 to 450 °C because aluminum lines are used (col. 5, 15-19).

Regarding claim 115, the carbon atoms are present as methyl groups if a methyl silane is used as the precursor gas, as admitted by Applicant. Note Ikeda uses methyl silane (col. 4, lines 30-42).

Regarding claims 116, 117, and further regarding claim **129**, the first layer inherently comprises $(CH_3)_XSiO_Y$ which inherently remains substantially as $(CH_3)_XSiO_Y$ based upon Applicant's admissions in the specification.

Regarding claims 118-121, **Ikeda** discloses repetitive cycles of from 0.1 to 30 seconds (col. 3, lines 15-17) and uses plural cycles as shown for example in Fig. 7. Accordingly the total exposure time is from 20, 40, 20-100, or at least 100 seconds.

Regarding claims 126-128, and further regarding claims **129**, 133, and 134 the dielectric constant is inherently 10% less or 15% less or between 2.0 and 2.5, because **Ikeda** uses the same method as presently claimed.

Regarding claim 124 and 131, **Ikeda** discloses the insulative layer is an interlevel dielectric (Figs. 4 and 6).

Regarding claim 140, as the pulsing on and off of the plasma occurs in a single chamber, the chemical vapor depositing and the blanket exposing occur without removing the substrate from the chamber.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims **102**-110, 112, 115-124, 126-128 and **129**-131, 133, 134, 140 are rejected under 35 U.S.C. 103(a) as unpatentable over **Yau** et al. (US 6,072,227) in view of **Morita** (JP 63-157443 A).

Regarding claims 102 and 129, **Yau** discloses the substrate **512** (Fig. 8A) having at least partially formed integrated circuitry formed thereon; depositing thereon a low k dielectric layer **510, 518**, (which may be a liner layer, cap layer, intermetal dielectric layer, or etch stop layer; [Abstract]) using a PECVD method with precursors of, for example, methylsilane and an oxygen containing gas, such as O_2 or N_2O (col. 5, lines 35-37). Note that the dielectric layer is porous

(col. 3, lines 13-29) and has a dielectric constant of less than 3.0 (**Yau**, claim 13) and in one example, a dielectric constant of 2.5 (col. 15, lines 5-18). The layer has from 1% to 50 % carbon from Si-CH_3 bonds. (See also, col. 12, line 41 to col. 13, line 52.)

Yau does not teach plasma treating the dielectric layer with oxygen plasma.

Morita discloses a very similar method to **Yau** comprising forming a low-dielectric-constant material comprising phenyl or alkyl silicon oxide **10** which inherently has a dielectric constant of less than 3.5 over an integrated circuit Fig. 2; blanket exposing the dielectric to oxygen plasma to form an upper surface **11** of silicon oxide which is inherently effective to reduce the dielectric constant. (See Figs. 1-2; page 2, lower two columns.) Note that a whole of the dielectric layer is not converted from one base to another (Applicant's claim 19) and that the $(CH_3)_xSiO_y$ remains as $(CH_3)_xSiO_y$. Moreover, claim 129 only requires the "whole" insulative layer to **comprise** $(CH_3)_XSiO_Y$ which does not require the whole layer to **be** $(CH_3)_XSiO_Y$. Note that the plasma exposure time is 10 minutes.

To quote from **Morita** at page 5,

> "When this semiconductor substrate 1 is exposed to an **oxygen plasma** for ten minutes, the **organic functional groups** of **organic** silicon thin film 10 **are removed** to a desired depth, transforming into a silicon oxide film. As such, the film thickness of organic silicon thin film 10 as initially formed, in its thinnest portions, transforms **nearly** entirely to silicon oxide film 11; only in the thickest portion does it come so as to have **a two-layer structure of silicon oxide film 11 and organic film 10** (figure 3)." (Emphasis added; page 5 of translation, lines 5-14).

Morita teaches that the oxygen plasma treatment solves the problem of poor insulation of the upper portion of organic spin-on glasses by removing the excess organic moieties at the surface, while beneficially preserving adhesion to the underlying layers by leaving the organic moieties in the lower portion of the film. The **Morita** exposure is indicated not to etch but, instead, only

removes a portion of the organic material in the surface of the deposited layer. (See translation provided by Applicant, section entitled "FUNCTION" beginning on p. 3.) While it is noted that a 10-minute exposure converts the thinnest portions of the insulative layer to silicon dioxide, the plasma exposure is still "**effective** to allow a base chemistry of the whole deposited first layer to remain substantially without transformation" since (1) no requisite is provided for "substantially;" and (2) since as noted above in the rejection of the claims under 35 USC 112(2), there exists no requirement for this step to even occur in independent claim 102, as it is not positively recited to occur.

Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Yau** to carry out the plasma treatment in **Morita** for the reasons just indicated in **Morita** for carrying out the plasma treatment. As indicated the dielectric would inherently be lowered because Applicant indicates that an oxygen plasma treatment will lower the dielectric constant. This makes common sense since the organic portion removed will leave behind additional porosity in the **Yau** dielectric layer, and space has the lowest dielectric constant attainable thereby lowering the overall dielectric constant of the layer.

Regarding claim 103, **Yau** discloses O_2 and N_2O and any oxygen containing gas, as noted above.

Regarding claims 104, 105 as noted above, **Morita** teaches oxygen which is not water and is therefore, dry oxygen.

Regarding claim 106-108, **Yau** discloses nitrous oxide, N_2O.

Regarding claim 109, **Yau** discloses methyl silane and N_2O deposition, and **Yau** teaches oxygen plasma exposure.

Regarding claim 110, the stability of the dielectric layer is inherently increased for the reasons indicated in **Morita** and by Applicant.

Regarding claim 112, **Morita** teaches that the organic silicon film is cured at 450 °C and no heating appears to be indicated; therefore, the temperature during exposure must be less than 550 °C.

Regarding claims 115, 122, 123, and 130, both **Yau** and **Morita** make the film from at least methylsilane. **Yau** specifically indicates that the film has from 1-50% carbon arising from Si-C bonds, preferably 20%. (col. 5, lines 12-44). Furthermore, Applicant has not indicated any criticality to the claimed portions. See In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable thereover because, among other reasons, there was *no evidence of the criticality* of the claimed ranges of molecular weight or molar proportions.). Any difference is a matter of routine optimization within prior art general conditions. (See MPEP 2144.05.)

Regarding claim 116, **Morita**, as noted above indicates that the exposure the organo dielectric leaves the organo dielectric substantially as its original composition. Since **Yau** teaches Applicant's specific method of deposition using Applicant's claimed methylsilane, the deposited film is $(CH_3)_XSiO_Y$, which would stay "substantially as $(CH_3)_XSiO_Y$" according to the teachings in **Yau** and by Applicant.

Regarding claims 117-121, although the time is not exactly as claimed by Applicant, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See In re Huang, 40 USPQ2d

1685, 1688(Fed. Cir. 1996). In the instant case, there exists no evidence of record to indicate that some unexpected result arises from the claimed time range relative to that in the applied art. It would have been obvious for one of ordinary skill in the art, at the time of the invention to use a shorter exposure time than in **Morita** since the dielectric layer formed by **Yau** is already porous and oxidized by the method of deposition rather than being a solid mass formed by a spin-on technique. The choice of exact time is an obvious matter of routine optimization to provide the best dielectric layer with the lowest reasonable dielectric constant.

Regarding claim 124 and 131, as noted above, the insulative layer may be an interlayer dielectric.

Regarding claims 126-128, 133, and 134, the **Yau** deposited dielectric layer is deposited with a dielectric constant of 2.5, as noted above. It is held absent evidence to the contrary that the dielectric constant is reduced by at least 10% or about 15% by exposure to the oxygen plasma and that the dielectric constant is inherently stabilized. If it is thought for some reason that the dielectric constant is not reduced or is not stabilized by exposure to the oxygen plasma, then these may be a difference. But, it has been held, where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on. (See MPEP 2112.) Given the similarity (if not equality) of the dielectric materials formed, the present evidence indicates that the dielectric constant must necessarily be reduced and stabilized.

Regarding claim 140, **Yau** deposits the insulating layer in a plasma CVD chamber and **Morita** exposes the insulating layer in a plasma chamber. Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention, to leave the Yau layer in the chamber for blanket exposure, in order to speed up throughput by preventing the transfer of the coated substrate to another chamber, as is highly desired in the semiconductor manufacturing art. Additionally, not moving the wafer between deposition and exposing prevents contamination to the wafer.

9. Claim 111 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Yau** in view of **Morita**, as applied to claims **102**-110, 112, 115-124, 126-128 above, and in further view of **Miyasaka** (US 6,017,779).

The prior art as explained above discloses all of the limitations of the claimed invention except for (1) depositing the $(CH_3)_xSiO_y$ layer and exposing in the same chamber is not taught (Applicant's claims 8 and 34); and (2) shutting off the silicon process gas and maintaining conditions in the chamber to expose the dielectric to the oxygen plasma is not taught (Applicant's claim 35).

Miyasaka teaches a method of forming a silicon oxide layer on a semiconductor device using plasma-enhanced CVD with silicon-containing compound and a oxygen-containing gas and then shutting off the silicon-containing precursor and then exposing to the oxygen plasma in the same chamber maintained at sub-atmospheric pressure. (See **Miyasaka**, column 44, "Example 6" especially lines 35-52.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify either of **Yau** in view of **Morita** to maintain a device in a single chamber as taught by **Miyasaka** in order to beneficially prevent contamination to the semiconductor device dielectric layer between process steps, as is well known in the art to do, and furthermore, because it would simplify the process dramatically by preventing a switch in chambers.

Response to Arguments

10. Applicant's arguments filed 12 October 2004 have been fully considered but they are not persuasive.

11. Applicant's comments regarding the restriction requirement are noted. Applicant's is advised that traversal of the restriction requirements are not drawn to appealable subject matter, but are instead drawn to petitionable subject matter. As such the Board will not consider Applicant's traversal of the restriction requirement.

12. Regarding the rejection under 35 USC 112(1) a as quoted from the rejection from the Office action filed 6/10/2004, (and as repeated above) beginning at the paragraph numbered "5,"

> "The specification fails to enable one of ordinary skill how to "blanket expose the first layer to an oxygen comprising plasma... that allows the base chemistry of **the whole** deposited first layer to remain substantially without transformation to another base chemistry after the blanket exposing converts the first layer to the insulative layer."

While Examiner acknowledges that Applicant alleges that the specification provides support that the above reduction of the dielectric constant can happen without changing the layer, merely because the specification states so --without evidence-- the specification and Applicant's arguments fail to address the evidence presented in each of the three references. Applicant's

allegation that the instant invention is novel and non-obvious --while clearly not novel and non-obvious based upon the prior art of record-- fails to eliminate the content of the three references indicating that the layers base chemistry cannot remain unaltered upon exposure to the oxygen-containing plasma. Additionally, one of ordinary skill would well know that the dielectric constant of a material is based upon what the material is, i.e. its composition, to suggest that the dielectric constant reduces without a change in the composition runs afoul of --not only the evidence pointed out in each of the three references-- but also of scientific fact. The specification fails to indicate how a material **composition** dependent property, i.e. the dielectric constant, of the insulating layer could be reduced without changing the composition of that insulating layer. Accordingly, the claims are not enabled. Finally it is noted that MPEP 2145 states that "argument does not replace evidence where evidence is necessary."

13. Regarding the rejection under 35 USC 112(1), as quoted herein below from the rejection from the Office action filed 6/10/2004, (and as repeated above) beginning at the paragraph numbered "6,"

> "The specification fails to provide support for the presently claimed combination of (1) using a dry oxygen plasma to deposit the first layer; (2) then converting the whole first layer to a the insulative layer using an oxygen plasma; and (3) without converting the base chemistry, reducing the dielectric constant of the insulative layer using an oxygen plasma."

Applicant argues that the specification provides support. Examiner respectfully disagrees. Applicant's arguments at p. 13 fail to address the combination. The rejection above does not contend that the "first layer" or the silicon-carbon-and-oxygen-containing first layer can be exposed to an oxygen plasma **to reduce the dielectric constant**, as argued by Applicant. Instead, the rejection contends that there exists no support for the above **combination**, most

specifically the portion wherein the silicon-carbon-and-oxygen-containing first layer **is converted into "the insulating layer"** because the silicon-carbon-and-oxygen-containing first layer is the insulating layer as deposited, **as made abundantly clear from the instant specification**. Such description was very clearly presented in the rejection of 6/10/2004 (and as repeated above) and has not been addressed by in Applicant's traversal. Accordingly the argument is not persuasive. Moreover, the amendment to claims 102 and 129 fail to remove the deficiency.

14. Applicant argues that Ikeda does not anticipate the indicated claims because Ikeda allegedly fails to use a plasma to deposit the first layer. (See Applicant's arguments beginning at p. 14 --especially p. 15.) First it is noted the Applicant specifically misquotes the Office action in alleging that Examiner relies on "col. 6, lines 33-51" when the Office action very clearly stated lines **9**-51 --not lines 33-51. It is perhaps curious that Applicant ignores the very portion of Ikeda that the Office action indicated should be considered by Applicant, as that section of Ikdea, col. 6, lines 9-32, specifically indicates that a **plasma** is, **in fact**, used to deposit the "first layer." Accordingly, the argument is wholly without merit as having ignored the expressed location in Ikeda where the claimed subject matter could be found.

Applicant argues that the oxygen plasma exposure does not reduce the dielectric constant. Examiner respectfully disagrees. Applicant's admissions in the specification that an oxygen plasma reduces the dielectric constant of the insulating layer, combined with the express teaching in Ikeda at col. 6, lines 9-51, indicate that the surface of the insulating layer on the substrate undergoes "oxygen ion bombardment" from the plasma generated oxygen ions. Such ions (1) convert surface precursors (i.e. the instantly claimed "first layer") into the insulating layer (i.e.

"the insulating layer" of the instant claims), and (2) inherently reduces the dielectric constant of the formed insulating layer. Because the plasma is pulsed, the first and second plasmas can be any of the pulses or sets of pulses. Accordingly the argument is not persuasive. Applicant has not provided evidence that the oxygen ion bombardment will not reduce the dielectric constant without converting the insulating layer from its base chemistry, as presently indicated in the instant specification will happen --the lack of enablement not withstanding.

Applicant additionally argues that Ikeda fails to indicate that carbon is bonded to silicon because TEOS is used in the one example in col. 6. Again, Applicant has ignored the rejection. The rejection, as repeated above specifically referred Applicant to col. 4, lines 30-39 of Ikeda wherein other CVD precursors containing silicon-carbon bonds are used in the instant method. Moreover, Ikeda provided specific examples, "EXAMPLE 6" in ocl 12 for example, which use the pulsed plasma method with OMCTS (octamethylcyclotetrasiloxane) which has eight silicon-carbon bonds in each molecule. Again, the argument is wholly without merit as having ignored the express teachings in Ikeda, as expressly pointed out in the Office action filed 6/10/2004.

Applicant additionally argues that the blanket exposing of the insulating layer occurs after completion of the deposition, but the claims fail to limit the deposition to only one layer. Each on-off cycle deposits a layer and nothing in the claims eliminates such additional layers. Accordingly the argument is not persuasive.

Applicant argues that the base chemistry of the layer is not maintained. Examiner respectfully submits that it is to every extent that the instant specification has enabled such a feature.

Applicant finally argues that Ikeda fails to teach each and every feature of claim 129. Examiner respectfully disagrees for reasons presented in the rejection. The features are taught explicitly, implicitly, and/or inherently, and Applicant has fails to contradict evidence presented in Applicant's own specification that such features are not present. Accordingly the argument is not persuasive.

15. Applicant's arguments regarding the rejection of Yau in view of Morita are noted. Applicant argues that Morita changes the base chemistry of the entire layer to silicon oxide. Applicant is mistaken. Morita makes very clear that the whole layer is not converted, but is instead only the surface is converted which is exactly what happens according to the instant specification, as has been noted in numerous Office actions. Morita specifically indicates that such conversion can be made "to a desired depth." Moreover, this feature of not converting the whole layer is not presently enabled in the instant specification for reasons already indicated.

Conclusion

16. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Erik Kielin
Primary Examiner
January 7, 2005